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(54) **COLOR SPACE INK MODEL GENERATION MECHANISM**

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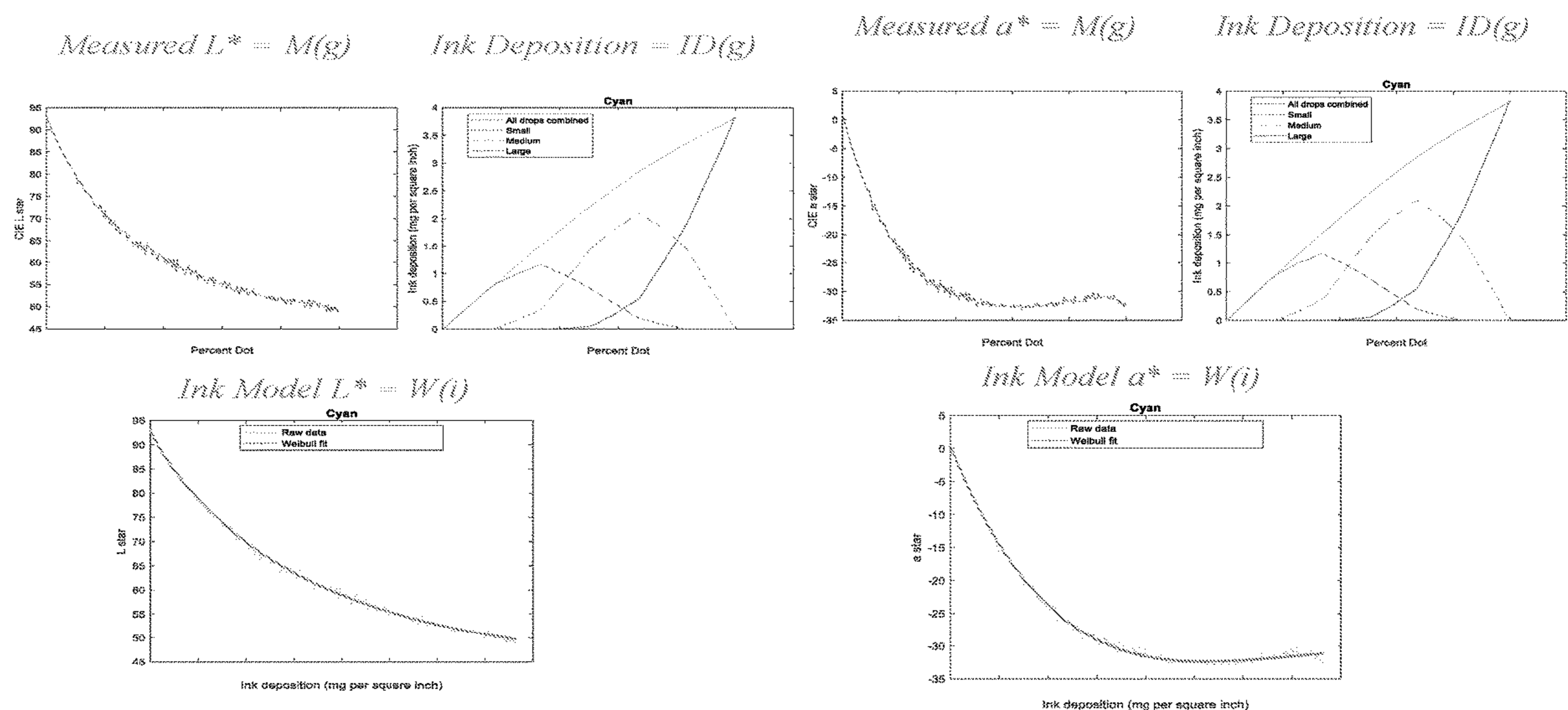
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(57) **ABSTRACT**

A printing system is disclosed. The printing system includes at least one physical memory device to store ink model estimation logic and one or more processors coupled with the at least one physical memory device to execute the ink model estimation logic to generate color space ink model parameter data for a print system based on an ink deposition data and color space measurement data for one of a plurality of inks for the print system.

17 Claims, 12 Drawing Sheets



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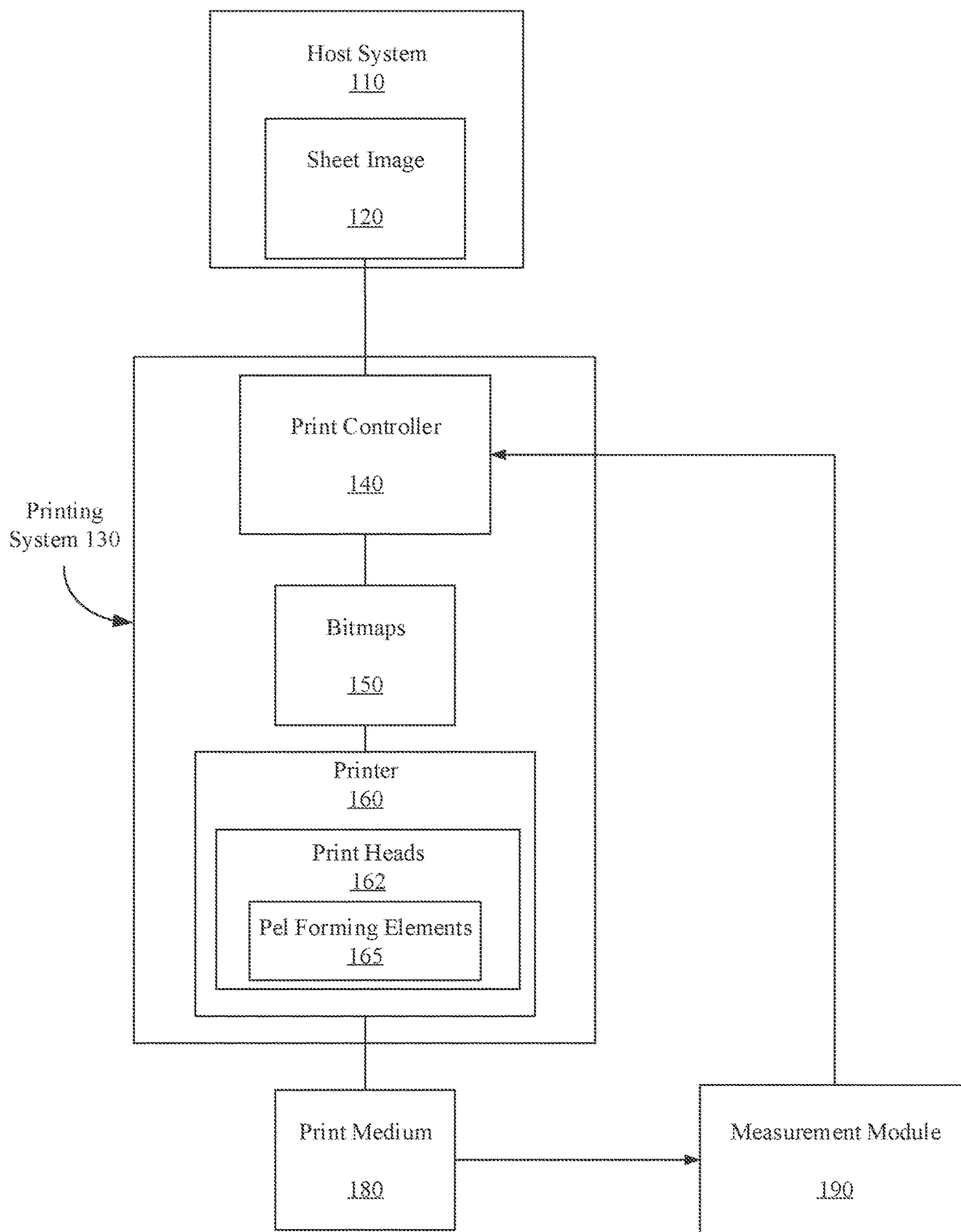


Figure 1

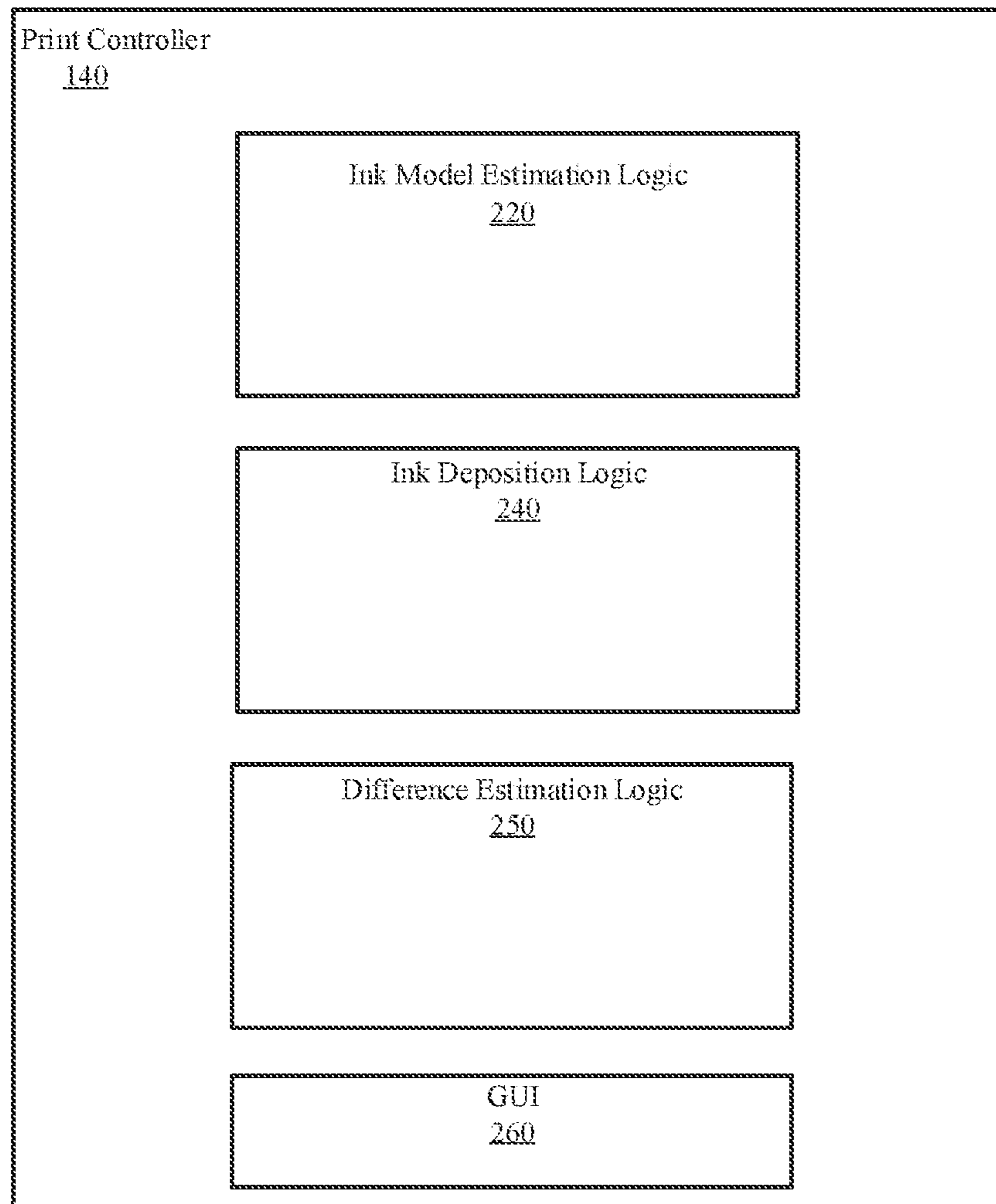


Figure 2A

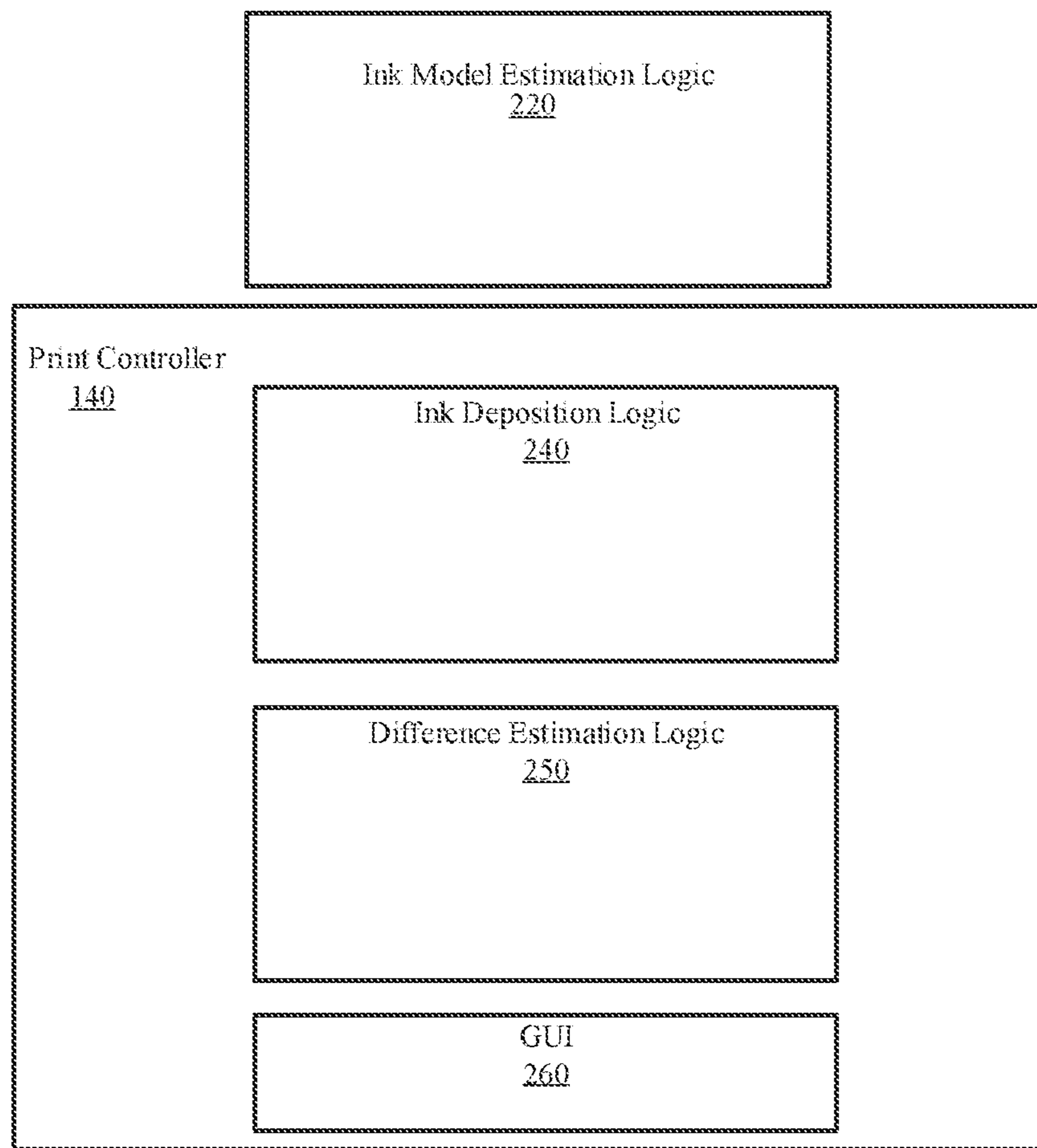


Figure 2B

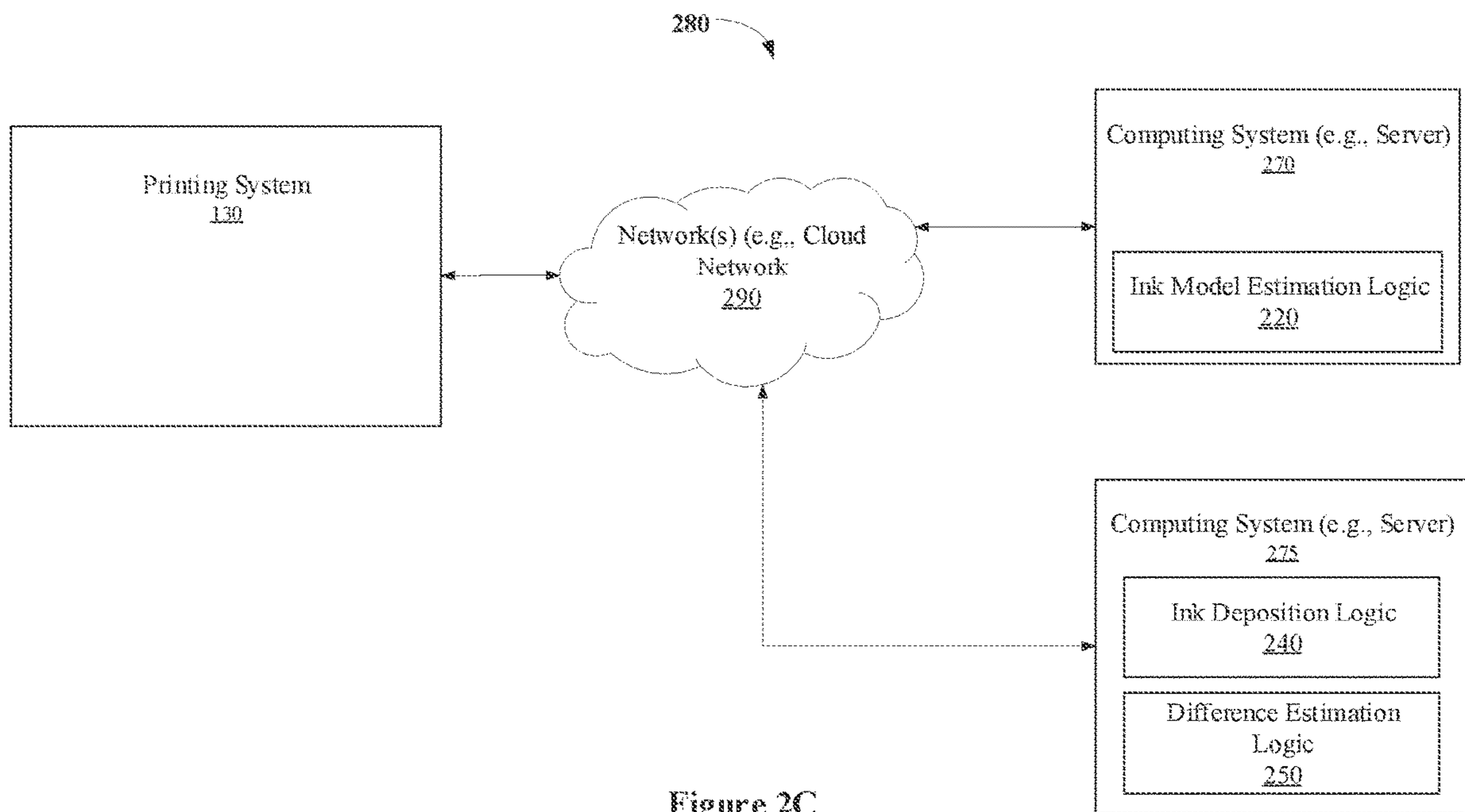


Figure 2C

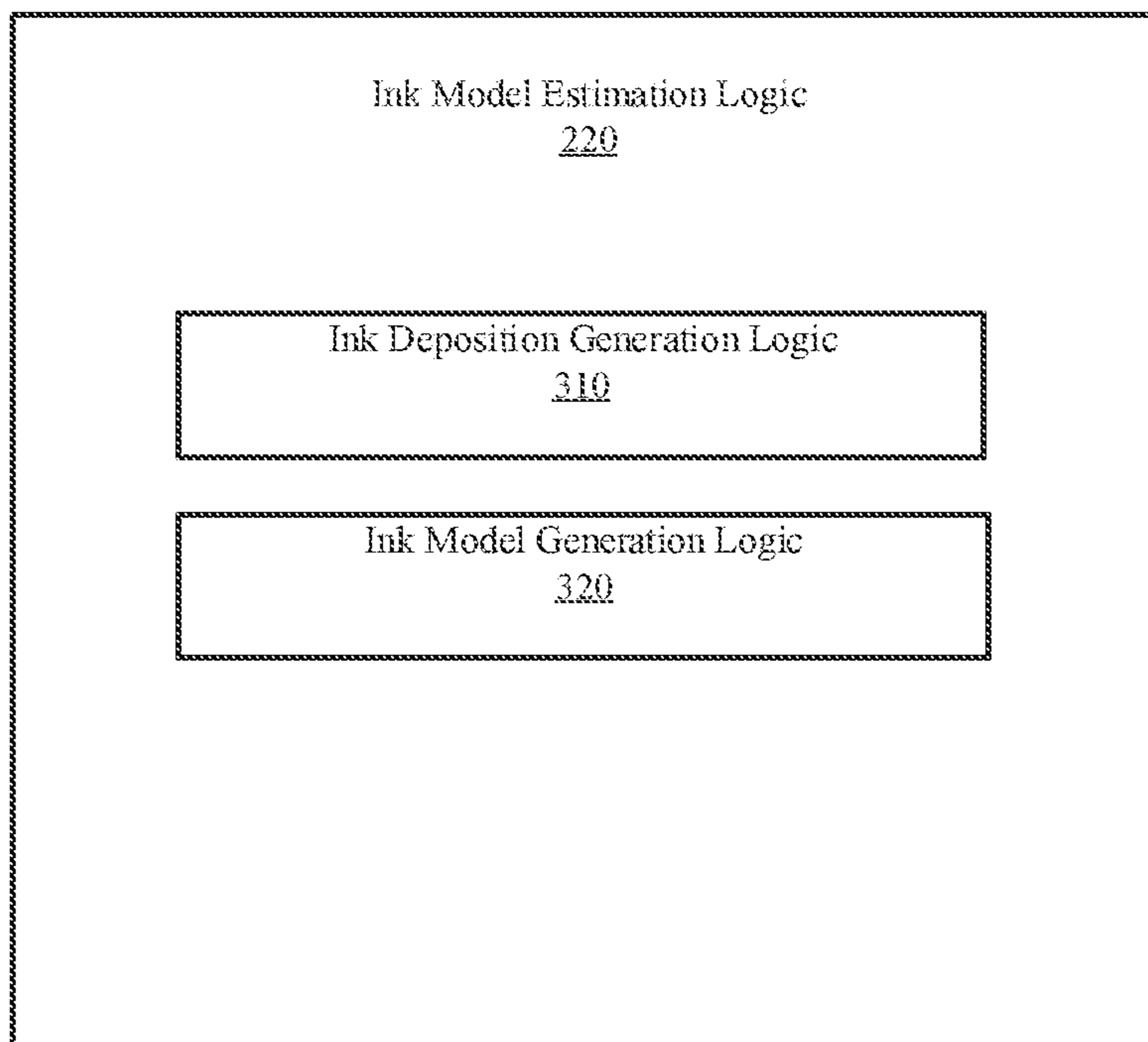


Figure 3

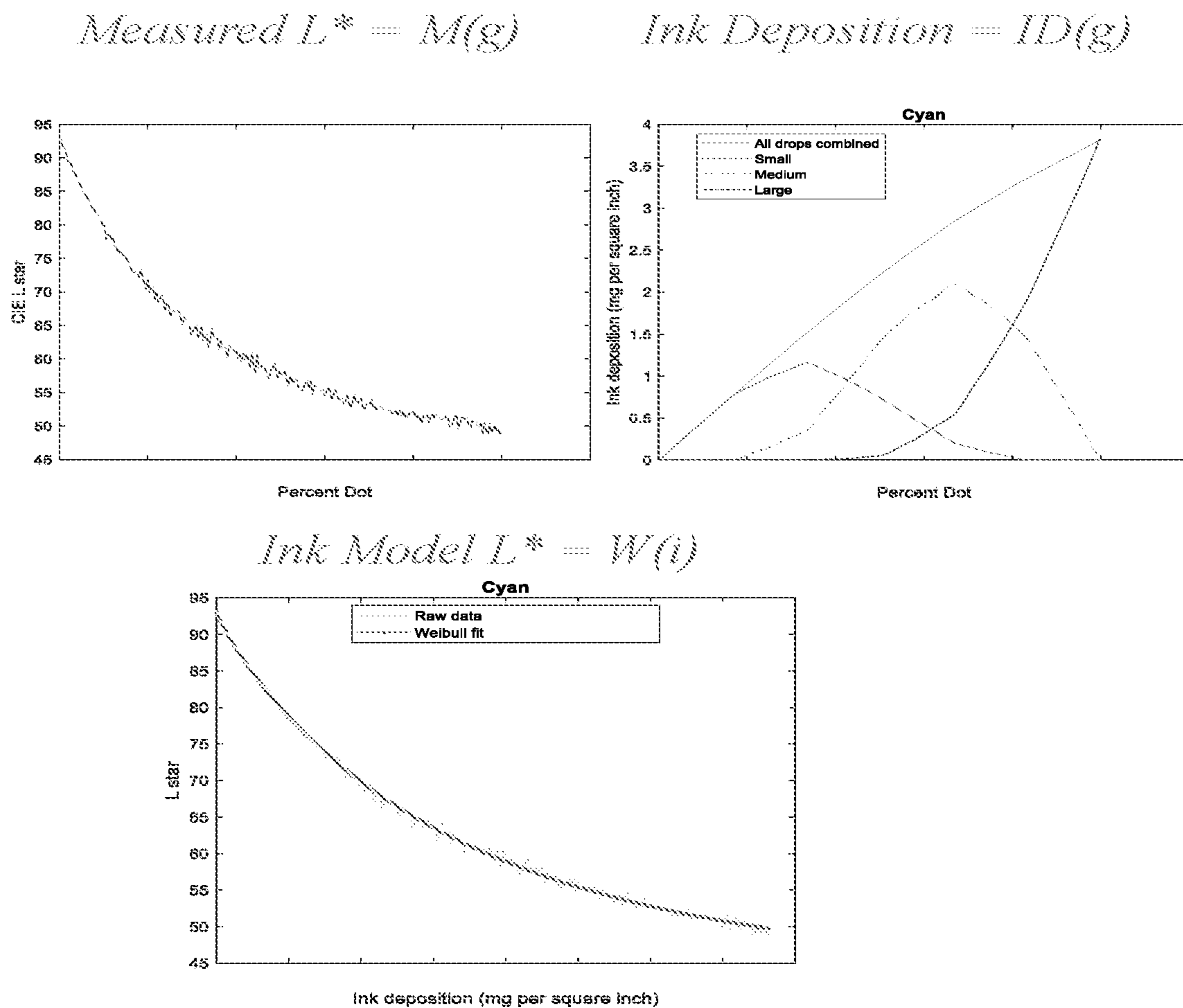


Figure 4A

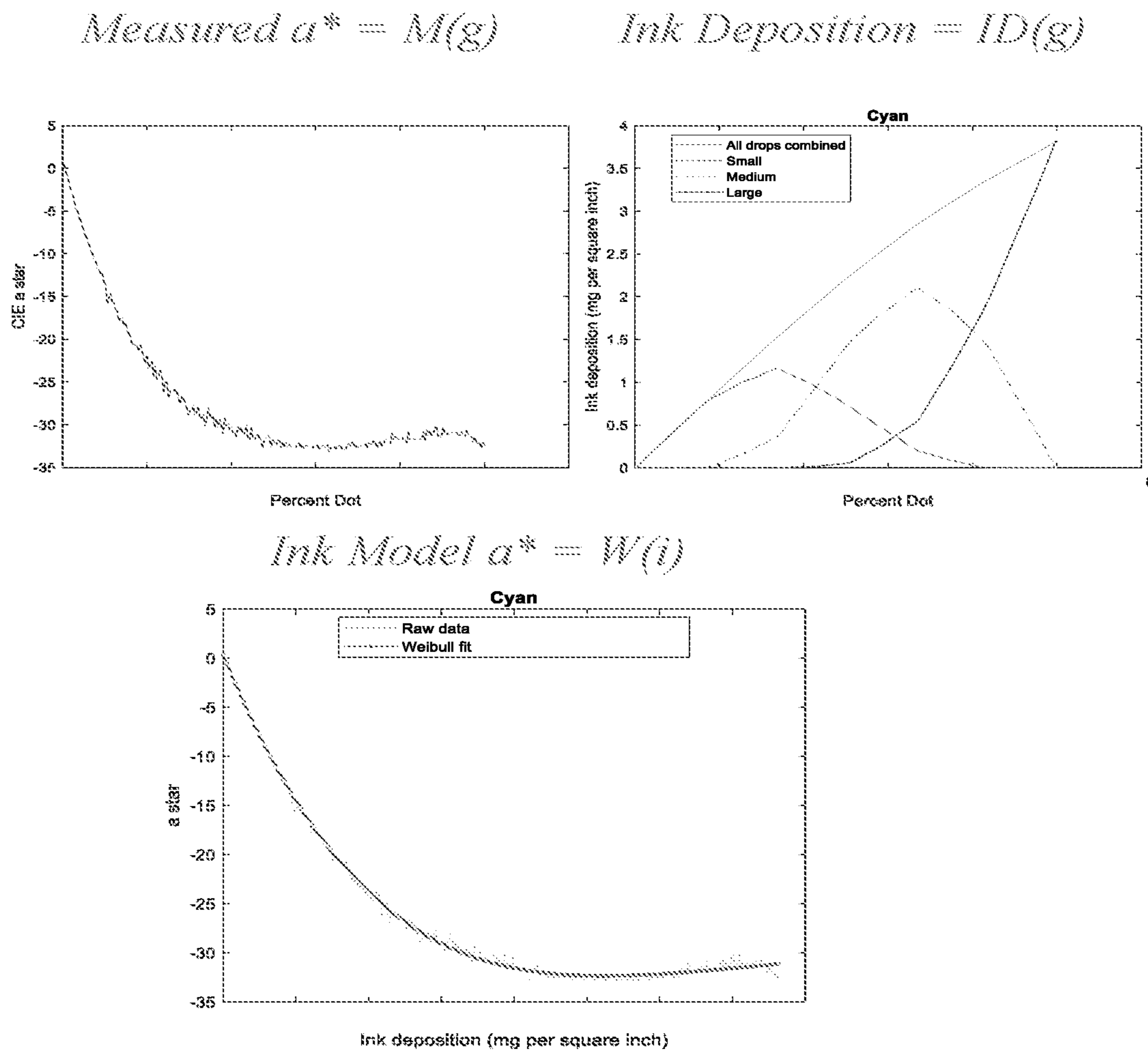
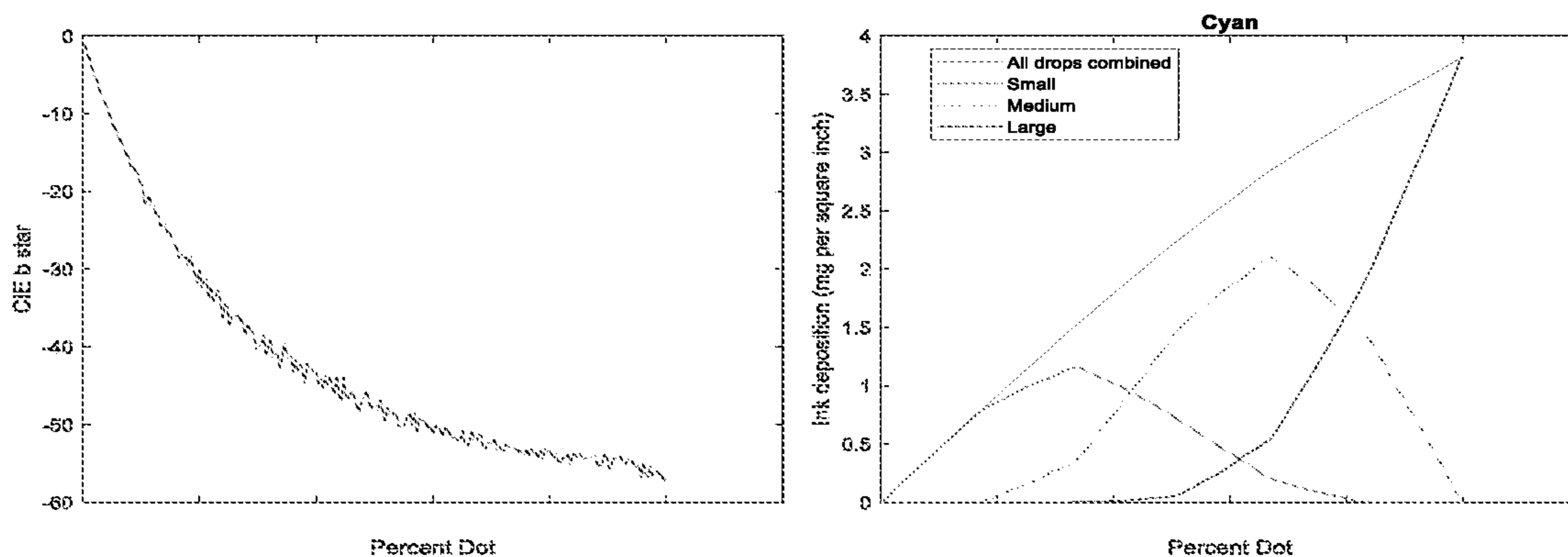


Figure 4B

Measured $b^ = M(g)$*

Ink Deposition = $ID(g)$



Ink Model $b^ = W(i)$*

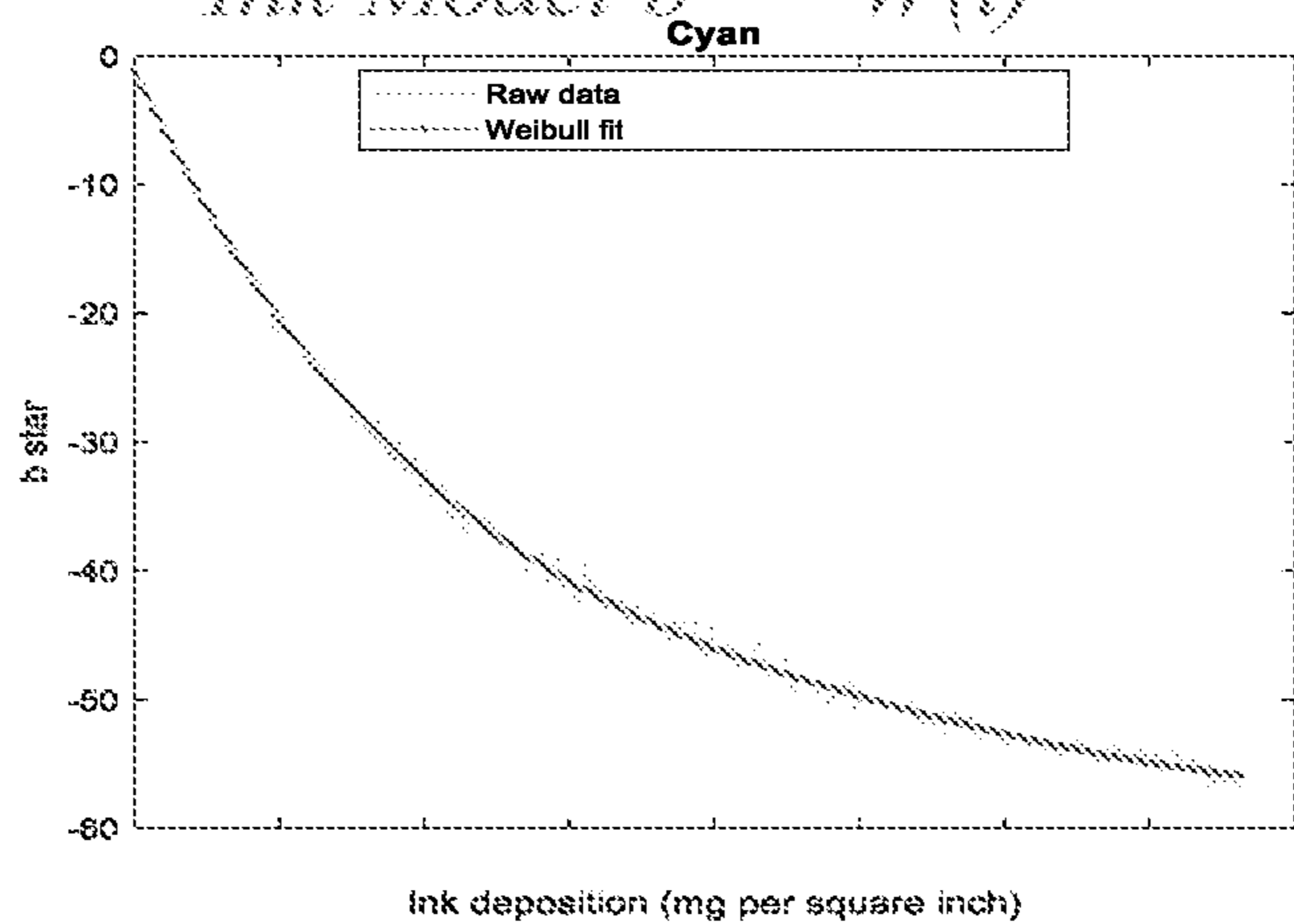


Figure 4C

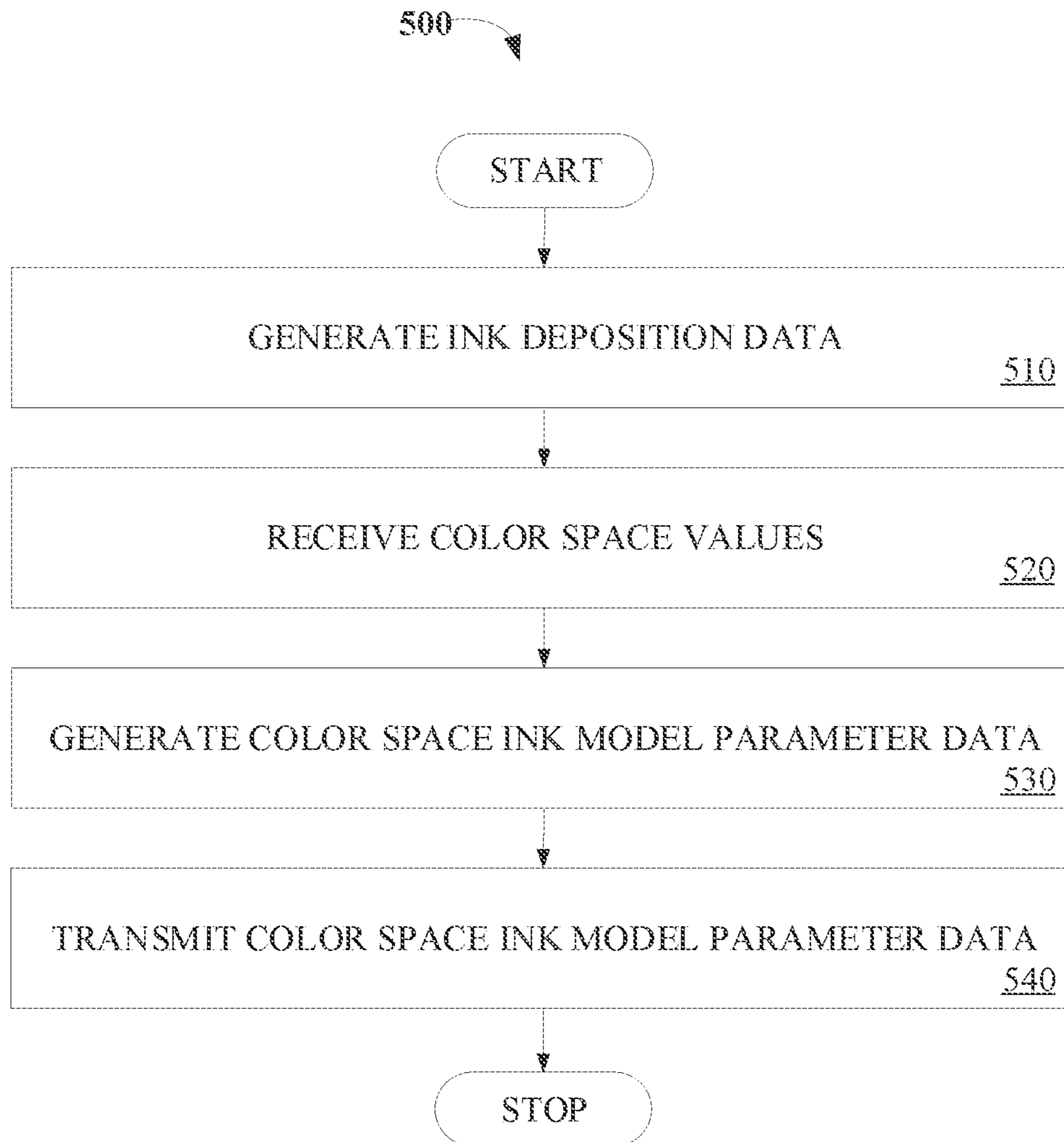


Figure 5

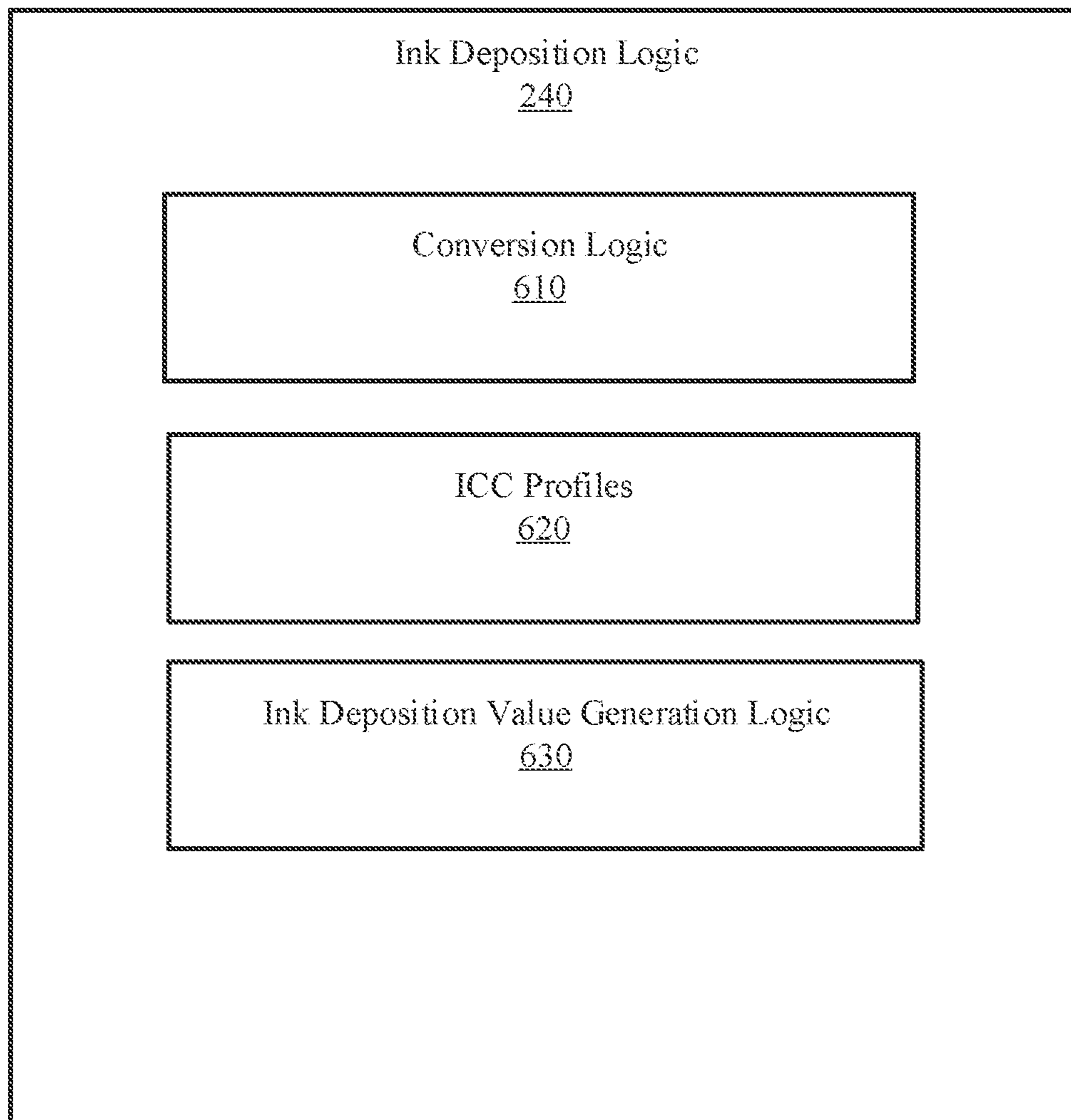


Figure 6

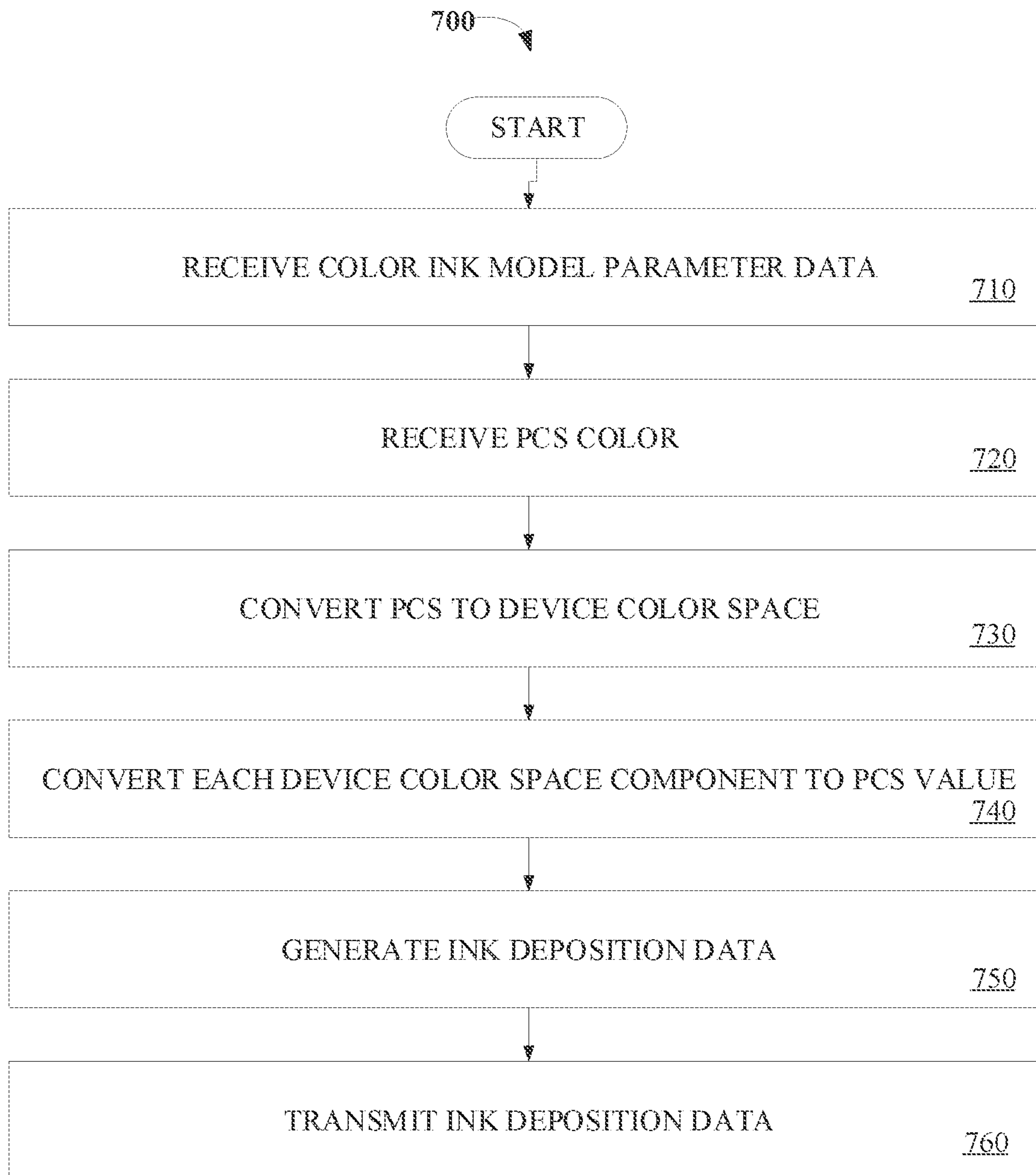


Figure 7

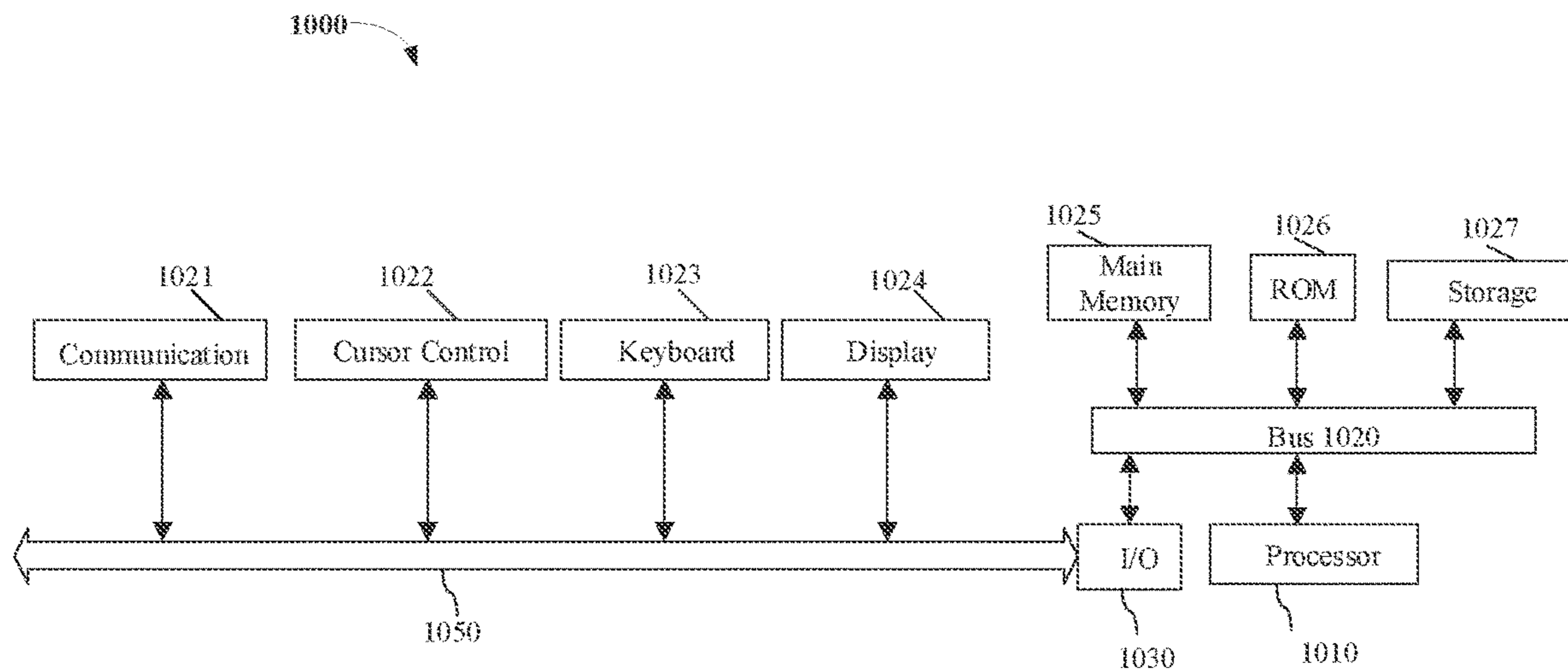


Figure 8

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COLOR SPACE INK MODEL GENERATION MECHANISM

FIELD OF THE INVENTION

The invention relates to the field of image reproduction.

BACKGROUND

Determining ink model parameter estimates typically involves applying an ink model to generate the parameter estimates based on OD vs ink deposition parameters. However, the application of conventional ink models to generate the parameters has limitations.

Accordingly, a mechanism to generate and implement color space ink model parameter data estimates is desired.

SUMMARY

In one embodiment, a printing system is disclosed. The printing system includes at least one physical memory device to store ink model estimation logic and one or more processors coupled with at least one physical memory device to execute the ink model estimation logic to generate color space ink model parameter data for a print system based on an ink deposition data and color space measurement data for one of a plurality of inks for the print system.

BRIEF DESCRIPTION OF THE DRAWINGS

A better understanding of the present invention can be obtained from the following detailed description in conjunction with the following drawings, in which:

FIG. 1 is a block diagram of one embodiment of a printing system;

FIGS. 2A&2B illustrate block diagrams of embodiments of a print controller;

FIG. 2C illustrates another embodiment of a print controller implemented in a network;

FIG. 3 illustrates one embodiment of ink model estimation logic;

FIGS. 4A-4C illustrate embodiment of graphs showing ink models and associated parameters;

FIG. 5 is a flow diagram illustrating one embodiment of an ink model computation process;

FIG. 6 illustrates one embodiment of ink deposition logic;

FIG. 7 is a flow diagram illustrating one embodiment of an ink deposition computation process; and

FIG. 8 illustrates one embodiment of a computer system.

DETAILED DESCRIPTION

A mechanism for generating and applying color space ink model parameter data estimates is described. In the following description, for the purposes of explanation, numerous specific details are set forth to provide a thorough understanding of the present invention. It will be apparent, however, to one skilled in the art that the present invention may be practiced without some of these specific details. In other instances, well-known structures and devices are shown in block diagram form to avoid obscuring the underlying principles of the present invention.

Reference in the specification to “one embodiment” or “an embodiment” means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment of the invention. The appearances of the phrase “in one embodiment” in

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various places in the specification are not necessarily all referring to the same embodiment.

FIG. 1 is a block diagram illustrating one embodiment of a printing system 130. A host system 110 is in communication with the printing system 130 to print a sheet image 120 onto a print medium 180 via a printer 160 (e.g., print engine). Print medium 180 may include paper, card stock, paper board, corrugated fiberboard, film, plastic, synthetic, textile, glass, composite or any other tangible medium suitable for printing. The format of print medium 180 may be continuous form or cut sheet or any other format suitable for printing. Printer 160 may be an ink jet, electrophotographic or another suitable printer type.

In one embodiment, printer 160 comprises one or more print heads 162, each including one or more pel forming elements 165 that directly or indirectly (e.g., by transfer of marking material through an intermediary) forms the representation of picture elements (pels) on the print medium 180 with marking material applied to the print medium. In an ink jet printer, the pel forming element 165 is a tangible device that ejects the ink onto the print medium 180 (e.g., an ink jet nozzle) and, in an electro-photographic (EP) printer the pel forming element may be a tangible device that determines the location of toner particles printed on the print medium (e.g., an EP exposure LED or an EP exposure laser).

The pel forming elements may be grouped onto one or more printheads. The pel forming elements 165 may be stationary (e.g., as part of a stationary printhead) or moving (e.g., as part of a printhead that moves across the print medium 180) as a matter of design choice. The pel forming elements 165 may be assigned to one of one or more color planes that correspond to types of marking materials (e.g., Cyan, Magenta, Yellow, and black (CMYK)).

In a further embodiment, printer 160 is a multi-pass printer (e.g., dual pass, 3 pass, 4 pass, etc.) wherein multiple sets of pel forming elements 165 print the same region of the print image on the print medium 180. The set of pel forming elements 165 may be located on the same physical structure (e.g., an array of nozzles on an ink jet print head) or separate physical structures. The resulting print medium 180 may be printed in color and/or in any of several gray shades, including black and white (e.g., Cyan, Magenta, Yellow, and black, (CMYK)). The host system 110 may include any computing device, such as a personal computer, a server, or even a digital imaging device, such as a digital camera or a scanner.

The sheet image 120 may be any file or data that describes how an image on a sheet of print medium 180 should be printed. For example, the sheet image 120 may include PostScript data, Printer Command Language (PCL) data, and/or any other printer language data. The print controller 140 processes the sheet image to generate a bitmap 150 for transmission. Bitmap 150 may be a halftoned bitmap (e.g., a calibrated halftone bit map generated from calibrated halftones, or uncalibrated halftone bit map generated from uncalibrated halftones) for printing to the print medium 180. The printing system 130 may be a high-speed printer operable to print relatively high volumes (e.g., greater than 100 pages per minute).

The print medium 180 may be continuous form paper, cut sheet paper, and/or any other tangible medium suitable for printing. The printing system 130, in one generalized form, includes the printer 160 that presents the bitmap 150 onto the print medium 180 (e.g., via toner, ink, etc.) based on the sheet image 120. Although shown as a component of print-

ing system **130**, other embodiments may feature printer **160** as an independent device communicably coupled to print controller **140**.

The print controller **140** may be any system, device, software, circuitry and/or other suitable component operable to transform the sheet image **120** for generating the bitmap **150** in accordance with printing onto the print medium **180**. In this regard, the print controller **140** may include processing and data storage capabilities. In one embodiment, measurement module **190** is implemented as part of ink model and drop size systems to obtain measurements of the printed medium **180**. The measured results are communicated to print controller **140** to be used to generate ink model parameter data, as well as generate drop size data. The measurement system may be a stand-alone process or be integrated into the printing system **130**.

According to one embodiment, measurement module **190** may be a sensor to take measurements of printed images on print medium **180**. Measurement module **190** may generate and transmit print image measurement data. Print image measurement data (e.g., color space measurement data) may be color response data for the parameters (e.g., coordinates) of a specific color space (e.g., CIELAB, CIEXYZ, etc.) corresponding to a printed image that is either raw or processed. In one embodiment, measurement module **190** may comprise one or more sensors that each or in total take measurements for printed markings produced for some or all pel forming elements **165**.

In another embodiment, measurement module **190** may be a camera system, in-line scanner, or spectrophotometer, where the preferred embodiment is a spectrophotometer. In a further embodiment, print image measurement data may include a map information to correlate portions (e.g., a pel or plurality of pels) of the print image data to the corresponding pel forming elements **165** that produced the portions of the printed images. In a further embodiment, measurement module **190** includes capability to measure ink volumes processed during printing, generate ink volume data and transmit ink volume data to allow one to determine the drop sizes ejected by the pel forming elements **165**.

FIGS. **2A&2B** illustrate embodiments implementing print controller **140**. FIG. **2A** illustrates a print controller **140** (e.g., DFE or digital front end), in its generalized form, including ink model estimation logic **220**, ink deposition logic **240** and difference estimation logic **250**. FIG. **2B** illustrates an embodiment in which print controller **140** includes ink deposition logic **240** and difference estimation logic **250**, while ink model estimation logic **220** is coupled externally. In either embodiment, the separate components may represent hardware used to implement the print controller **140**. Alternatively, or additionally, the separate components may represent logical blocks implemented by executing software instructions in a processor of the printer controller **140**.

Although shown as a component outside of print controller **140**, other embodiments may feature one or more of ink model estimation logic **220**, ink deposition logic **240** and difference estimation logic **250** included within independent devices, or combination of devices, communicably coupled to print controller **140**. For instance, FIG. **2C** illustrates one embodiment of ink model estimation logic **220**, ink deposition logic **240** and difference estimation logic **250** implemented in a network **280**. As shown in FIG. **2C**, ink model estimation logic **220** is included in a computing system **270**, while ink deposition logic **240** and difference estimation logic **250** are included within a computing system **275**. In

one embodiment, each component transmits data to printing system **130** via a cloud network **290**.

According to one embodiment, ink model estimation logic **220** generates color space ink model parameter data for a print system based on an ink deposition data and device independent color space measurement data for each ink color (e.g., CMYK) implemented in printing system **130**. In such embodiments, the color space ink model (e.g., a set of parametric equations that include the color space parameters) represents a relationship between parameter values in a color space and ink deposition. In further embodiments, the ink deposition data represents a relationship between ink deposition and a print system input control (e.g., digital count, gray level, percent dot, etc.), and the color space measurement data represents a relationship between a color space parameters (e.g., L*, a* or b* for CIELAB color space) and the print system input control.

As used herein, ink deposition is defined as an average amount of ink deposited per printed device pel, where a pel is a picture element of the printer **160** (e.g., the printing device). Since the physical spacing of pels of printer **160** is known, the pels of printer **160** may be readily converted to area. The print system input control comprises a digital count that is a gray level representing the pels in bitmap **150**. In one embodiment, the amount of ink deposition changes as a function of print system input control (e.g., digital count, gray level, percent dot, etc.). In such an embodiment, the digital count for pels in bitmap **150** range from 0-255 for a typical 8 bit system. Additionally, the digital count is a control parameter of an output pel. In yet a further embodiment, the ink deposition data may be represented as an ink deposition curve, which defines the ink deposition over the range of all possible gray levels (e.g., 0-255). In such an embodiment, ink deposition may be computed on an average basis to eliminate local variations due to halftoning using a set of discrete drop sizes.

FIG. **3** illustrates one embodiment of ink model logic **220**. As shown in FIG. **3**, ink model estimation logic **220** includes ink deposition generation logic **310** and ink model generation logic **320**. According to one embodiment, ink deposition generation logic **310** generates the ink deposition data that is used to generate the color space ink model parameter data. In such an embodiment, ink deposition generation logic **310** generates the ink deposition data based on received drop size data and halftone drop fractions (or drop counts) resulting from the printing of test print jobs (e.g., printed at printing system **130** and measured at measurement module **190**).

Ink drop sizes may be determined by analyzing an amount of ink used as measured by **190** and counts of ink drops of each size, where counts are obtained by counting the different drops commanded to drive the pel forming elements **165**. Regression is employed to determine drop sizes by relating the amount of ink used and the respective drop counts for the same jobs being printed.

Ink model generation logic **320** generates color space ink model parameter data based on the generated ink deposition data and received color space measurement data. In one embodiment, the color space measurement data comprises CIELAB color space (or CIF L*a*b*) values. However in other embodiments, other color space values (e.g., CIEXYZ) may be implemented. By generating a color space ink model that is based on the parameters of the color space (e.g., CIELAB), the ink deposition CMYK) for the input color space value may be efficiently determined as shown below.

In one embodiment, color space ink model parameter data comprises parameter estimates that are generated by applying an ink model, such as a Weibull ink model regression, to

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create a relationship between CIELAB color space parameters and ink deposition data. Weibull cumulative distribution function (CDF) describes the probability that a real-valued random variable X with a given probability will be found at a value less than or equal to x (where x is a one possible value of the random variable X). Intuitively, it is the “area under the curve” function of the probability density function (PDF). Cumulative distribution functions are also used to specify the distribution of multivariate random variables.

In one embodiment, the Weibull CDF is modified to describe a quantity of ink deposition that is required to achieve specific L^* , a^* , b^* (or Lab) values. This modified Weibull CDF will be described as simply “Weibull CDF”. The forward Weibull CDF relates ink deposition to Lab, while the inverse Weibull CDF relates Lab to ink deposition.

In one embodiment, the Weibull CDF models L^* vs ink deposition as:

$$L^* = \left(p(3) * \left(1 - e^{-\left(\frac{x}{p(1)}\right)^{p(2)}} \right) \right) + p(4)$$

Meanwhile a fourth order polynomial is implemented to model a^* or b^* vs ink deposition, such that:

$$a^* = (p(5) * x^4) + (p(6) * x^3) + (p(7) * x^2) + (p(8) * x) + p(9); \text{ and}$$

$$b^* = (p(10) * x^4) + (p(11) * x^3) + (p(12) * x^2) + (p(13) * x) + p(14), \text{ where}$$

L^* and a^* are CIE Lab L^* and a^* respectively; x is the ink deposition (e.g., mg per square inch); $p(1)$ is the Weibull scale parameter, $p(2)$ is a Weibull slope parameter; $p(3)$ is a solid area/infinite ink deposition L^* parameter; $p(4)$ is a Paper L^* ; $p(5)$ is a fourth order parameter for a^* ; $p(6)$ is a third parameter for a^* ; $p(7)$ is a second parameter for a^* ; $p(8)$ is a linear parameter for a^* ; $p(9)$ is a constant parameter for a^* ; b^* is CIE Lab b^* ; x is the ink deposition (e.g., mg per square inch); $p(10)$ is a fourth order parameter for b^* ; $p(11)$ is a third parameter for b^* ; $p(12)$ is a second parameter for b^* ; $p(13)$ is a linear parameter for b^* ; and $p(14)$ is a constant parameter for b^* . For generating the L^* Weibull ink model, an exponential regression is performed, such that

$$L^* = W(i) = M(ID^{-1}(i)), \text{ where}$$

$ID(g)$ is an uncalibrated ink deposition a function of gray level g ; $M(g)$ is a measured L^* as a function of gray level g ; and W is the ink model $W(i)$ as a function of ink deposition i , which relates L^* to ink deposition. As referred to herein, a gray level is synonymous with a digital count. The inverse relationship can be used to determine the ink deposition from the L^* values, as represented as:

$$W^{-1}(L^*) = ID(M^{-1}(L^*)).$$

FIG. 4A illustrates one embodiment of graphs showing the L^* Weibull ink model, and parameters L^* and ink deposition.

For generating the a^* Weibull ink model, a fourth order regression model used to fit the ink model W to a^* , such that:

$$a^* = W(i) = M(ID^{-1}(i)), \text{ where}$$

$M(g)$ is the measured a^* as a function of gray level g . The inverse relationship can be used to determine the ink deposition from the a^* values, as represented as:

$$W^{-1}(a^*) = ID(M^{-1}(a^*))$$

FIG. 4B illustrates one embodiment of graphs showing the a^* Weibull ink model, and parameters a^* and ink deposition.

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For generating the b^* Weibull ink model, a fourth order regression model used to fit the ink model W to b^* , such that:

$$b^* = W(i) = M(ID^{-1}(i)), \text{ where}$$

$M(g)$ is the measured b^* as a function of gray level g . The inverse relationship can be used to determine the ink deposition from the b^* values, as represented as:

$$W^{-1}(b^*) = ID(M^{-1}(b^*))$$

FIG. 4C illustrates one embodiment of graphs showing the b^* Weibull ink model, and parameters b^* and ink deposition.

FIG. 5 is a flow diagram illustrating one embodiment of a process 500 for performing an ink model computation. Process 500 may be performed by processing logic that may include hardware (e.g., circuitry, dedicated logic, programmable logic, microcode, etc.), software such as instructions run on a processing device, or a combination thereof. In one embodiment, process 500 is performed by ink model estimation logic 220.

According to one embodiment, process 500 begins at processing block 510, where ink deposition data is generated or received. As discussed above, the ink deposition data is generated based on received drop size data and drop fraction data. At processing block 520, input color space values (e.g., CIELAB) are received. At processing block 530, color space ink model parameter data is generated by applying the L^* , a^* and b^* models to the received color space values and ink deposition data. At processing block 540, the color space ink model parameter data is transmitted.

Referring to FIG. 2, ink deposition logic 240 is implemented to generate ink deposition data for each of a plurality of input colors (e.g., CMYK) implemented at printing system 130. In one embodiment, ink deposition logic 240 receives the color space ink model parameter data from ink model estimation logic 220 and applies the color space ink model parameter data to each input color to generate ink deposition data for each of the input colors. FIG. 6 illustrates one embodiment of ink deposition logic 240, including conversion logic 610, one or more International Color Consortium (ICC) profiles 620, and ink deposition value generation logic 630.

Conversion logic 610 is implemented to perform color space conversions. According to one embodiment, conversion logic 610 converts between a profile connection space (PCS) (e.g., CIELAB) and a device color space (e.g., CMYK). In such an embodiment, conversion logic 610 uses an ICC profile 620 to perform a mapping between CIELAB and CMYK colors. ICC profiles describe color attributes of a particular device or viewing requirement by defining mappings between a device color space and device independent color space.

In one embodiment conversion logic 610 receives input color space values (e.g., CIELAB color values) and uses an ICC profile 620 to convert the CIELAB color value to a CMYK color value (e.g., PCS to device space conversion). In a further embodiment, conversion logic 610 performs a second conversion to convert each color component of the CMYK color value to a CIELAB color value (e.g., device space to PCS conversion) using ICC profiles 620. In such an embodiment, each CMYK primary color component comprises a digital count (DC_X), which when converted results in separate L^*_X , a^*_X and b^*_X values associated with each primary color component. Thus, the second conversion results in L^*_X , a^*_X and b^*_X values being generated for each of the C, M, Y and K digital count values.

Ink deposition value generation logic **630** receives the L^*_X , a^*_X and b^*_X values and generates ink deposition data. In one embodiment, ink deposition value generation logic **630** generates the ink deposition data by applying the inverse L^* , a^* and b^* ink models to the L^*_X , a^*_X and b^*_X values and the previously received color space values. As a result, ink deposition values (e.g., $ID_{L^*_X}$, $ID_{a^*_X}$, and $ID_{b^*_X}$) are generated for each original primary color component.

In a further embodiment, ink deposition value generation logic **630** subsequently combines (e.g., using averaging) the ink deposition values associated with each primary color to generate an ink deposition data value (ID_X) corresponding to each of the primary color components. In such an embodiment, $ID_{L^*_X}$, $ID_{a^*_X}$, and $ID_{b^*_X}$ for C is combined to generate ID_C data; $ID_{L^*_X}$, $ID_{a^*_X}$, and $ID_{b^*_X}$ for M is combined to generate ID_M data; $ID_{L^*_X}$, $ID_{a^*_X}$, and $ID_{b^*_X}$ for Y is combined to generate ID_Y data; and $ID_{L^*_X}$, $ID_{a^*_X}$, and $ID_{b^*_X}$ for K is combined to generate ID_K data.

In some cases, since the inverse may not be single values, the correct single inverse ink deposition values must be determined. One method that can be employed uses the ink deposition derived from the L^* vs ink deposition. The inverse L^* relationship produces a single value which can then be used to resolve the proper ink deposition values to use from the inverse a^* and inverse b^* determinations. Once generated, the ink deposition data (ID_C , ID_M , ID_Y and ID_K) is transmitted. In one embodiment, the ink deposition data is transmitted with the original input CIELAB color values and converted CMYK color values. This provides the CMYK ink deposition values for any CIELAB color.

FIG. 7 is a flow diagram illustrating one embodiment of a process **700** for generating ink deposition data. Process **700** may be performed by processing logic that may include hardware (e.g., circuitry, dedicated logic, programmable logic, microcode, etc.), software such as instructions run on a processing device, or a combination thereof. In one embodiment, process **700** is performed by ink deposition logic **240**.

According to one embodiment, process **700** begins at processing block **710**, where color ink model parameter data is received. As discussed above, the color ink model parameter data may be received from ink model estimation logic **220**. At processing block **720**, a PCS color is received. As mentioned above, the PCS color comprises a CIELAB color value.

At processing block **730**, the PCS color is converted to a device color space color (e.g., CMYK) value. At processing block **740**, each device color space component is converted to a separate PCS color value (L^*_X , a^*_X and b^*_X). At processing block **750**, ink deposition data is generated by applying the L^* , a^* and b^* ink models to the L^*_X , a^*_X and b^*_X values for each device color space component (X), and combining the values to generate the ID_C , ID_M , ID_Y and ID_K . Combining includes the step of resolving the proper ink deposition to use in the case of multiple values. At decision block **760**, the ink deposition data is transmitted.

Referring to FIG. 2, difference estimation logic **250** receives ink deposition data and associated color data and determines color differences (Delta E) and/or ink deposition differences (Delta IDs) for a plurality of color values. In one embodiment, difference estimation logic **250** stores each color value and associated ink deposition data received from ink deposition logic **240** as color samples. In such an embodiment, an operator (or user) may select two or more

color samples (e.g., via a graphical user interface (GUI) **260** at print controller **140**) to perform a difference analysis.

Once selected, difference estimation logic **250** performs the difference analysis by comparing the color data and/or ink deposition data for each sample and generating Delta E and/or Delta IDs between the color samples. In one embodiment, the Delta Es and/or Delta IDs are displayed via GUI **260**. However, in other embodiments, the Delta Es and/or Delta IDs are transmitted to another entity. By determining Delta Es and/or Delta IDs based on ink deposition for the input color samples, the differences between the input color samples may be efficiently determined.

FIG. 8 illustrates a computer system **1000** on which printing system **130**, print controller **140**, computing system **270** and/or computing system **275** may be implemented. Computer system **1000** includes a system bus **1020** for communicating information, and a processor **1010** coupled to bus **1020** for processing information.

Computer system **1000** further comprises a random access memory (RAM) or other dynamic storage device **1025** (referred to herein as main memory), coupled to bus **1020** for storing information and instructions to be executed by processor **1010**. Main memory **1025** also may be used for storing temporary variables or other intermediate information during execution of instructions by processor **1010**. Computer system **1000** also may include a read only memory (ROM) and or other static storage device **1026** coupled to bus **1020** for storing static information and instructions used by processor **1010**.

A data storage device **1027** such as a magnetic disk or optical disc and its corresponding drive may also be coupled to computer system **1000** for storing information and instructions. Computer system **1000** can also be coupled to a second I/O bus **1050** via an I/O interface **1030**. A plurality of I/O devices may be coupled to I/O bus **1050**, including a display device **1024**, an input device (e.g., an alphanumeric input device **1023** and or a cursor control device **1022**). The communication device **1021** is for accessing other computers (servers or clients). The communication device **1021** may comprise a modem, a network interface card, or other well-known interface device, such as those used for coupling to Ethernet, token ring, or other types of networks.

Embodiments of the invention may include various steps as set forth above. The steps may be embodied in machine-executable instructions. The instructions can be used to cause a general-purpose or special-purpose processor to perform certain steps. Alternatively, these steps may be performed by specific hardware components that contain hardwired logic for performing the steps, or by any combination of programmed computer components and custom hardware components.

Elements of the present invention may also be provided as a machine-readable medium for storing the machine-executable instructions. The machine-readable medium may include, but is not limited to, floppy diskettes, optical disks, CD-ROMs, and magneto-optical disks, ROMs, RAMs, EPROMs, EEPROMs, magnetic or optical cards, or other type of media/machine-readable medium suitable for storing electronic instructions. For example, the present invention may be downloaded as a computer program which may be transferred from a remote computer (e.g., a server) to a requesting computer (e.g., a client) via a communication link (e.g., a modem or network connection).

The following clauses and/or examples pertain to further embodiments or examples. Specifics in the examples may be used anywhere in one or more embodiments. The various features of the different embodiments or examples may be

variously combined with some features included and others excluded to suit a variety of different applications. Examples may include subject matter such as a method, means for performing acts of the method, at least one machine-readable medium including instructions that, when performed by a machine cause the machine to perform acts of the method, or of an apparatus or system according to embodiments and examples described herein.

Some embodiments pertain to Example 1 that includes a system comprising at least one physical memory device to store ink model logic; and one or more processors coupled with the at least one physical memory device to execute the ink model logic to generate color space ink model parameter data for a print system based on an ink deposition data and color space measurement data for one of a plurality of inks for the print system.

Example 2 includes the subject matter of Example 1, wherein the color space ink model represents a relationship between values of a color space and ink deposition data for the one of a plurality of inks for the print system.

Example 3 includes the subject matter of Examples 1 and 2, wherein the ink deposition data represents a relationship between the ink deposition and a print system input control for one of a plurality of inks for the print system.

Example 4 includes the subject matter of Examples 1-3, wherein the color space measurement data represents a relationship between one of a plurality of color space parameters and the print system input control.

Example 5 includes the subject matter of Examples 1-4, wherein the ink deposition data comprises an amount of printed ink per print medium area.

Example 6 includes the subject matter of Examples 1-5, wherein the print system input control comprises a digital count.

Example 7 includes the subject matter of Examples 1-6, wherein the ink model estimation logic further generates a parametric equation for each of the plurality of color space parameters.

Example 8 includes the subject matter of Examples 1-7, wherein the color space ink model comprises Weibull cumulative distribution function (CDF) parameters.

Example 9 includes the subject matter of Examples 1-8, further comprising a controller.

Example 10 includes the subject matter of Examples 1-9, wherein the at least one physical memory device to store ink deposition logic and the one or more processors to execute the ink deposition logic to determine ink deposition data for an input color of the color space for the print system based on the color space ink model and an input color space value.

Some embodiments pertain to Example 11 that includes a method comprising generating color space ink model parameter data for a print system based on an ink deposition data and color space measurement data for one of a plurality of inks for the print system.

Example 12 includes the subject matter of Example 11, wherein the color space ink model represents a relationship between values of a color space and ink deposition data for the one of a plurality of inks for the print system.

Example 13 includes the subject matter of Examples 11 and 12, wherein the ink deposition data represents a relationship between the ink deposition and a print system input control for one of a plurality of inks for the print system.

Example 14 includes the subject matter of Examples 11-13, wherein the color space measurement data represents a relationship between one of a plurality of color space parameters and the print system input control.

Example 15 includes the subject matter of Examples 11-14, further comprising generating a parametric equation for each of the plurality of color space parameters.

Some embodiments pertain to Example 16 that includes at least one computer readable medium having instructions stored thereon, which when executed by one or more processors, cause the processors to generate color space ink model parameter data for a print system based on an ink deposition data and color space measurement data for one of a plurality of inks for the print system.

Example 17 includes the subject matter of Example 16, wherein the color space ink model represents a relationship between values of a color space and ink deposition data for the one of a plurality of inks for the print system.

Example 18 includes the subject matter of Examples 16 and 17, wherein the ink deposition data represents a relationship between the ink deposition and a print system input control for one of a plurality of inks for the print system.

Example 19 includes the subject matter of Examples 16-18, wherein the color space measurement data represents a relationship between one of a plurality of color space parameters and the print system input control.

Example 20 includes the subject matter of Examples 16-19, having instructions stored thereon, which when executed by one or more processors, further cause the processors to generate a parametric equation for each of the plurality of color space parameters.

Whereas many alterations and modifications of the present invention will no doubt become apparent to a person of ordinary skill in the art after having read the foregoing description, it is to be understood that any particular embodiment shown and described by way of illustration is in no way intended to be considered limiting. Therefore, references to details of various embodiments are not intended to limit the scope of the claims, which in themselves recite only those features regarded as essential to the invention.

What is claimed is:

1. A system comprising:

at least one physical memory device to store ink model estimation logic; and

one or more processors coupled with the at least one physical memory device to execute the ink model estimation logic to generate color space ink model parameter data for a print system based on an ink deposition data and color space measurement data for one of a plurality of primary color inks for the print system, wherein the color space measurement data represents color response data for each of a plurality of parameters in a device independent color space and the color space ink model parameter data represents a relationship between each of the plurality of parameters of the device independent color space and ink deposition data for the one of the plurality of primary color inks for the print system.

2. The system of claim 1, wherein the ink deposition data represents a relationship between the ink deposition and a print system input control for one of a plurality of inks for the print system.

3. The system of claim 2, wherein the ink deposition data comprises an amount of printed ink per print medium area.

4. The system of claim 1, wherein the color space measurement data represents a relationship between each of the plurality of color space parameters and the print system input control.

5. The system of claim 4, wherein the print system input control comprises a digital count.

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6. The system of claim **1**, wherein the ink model estimation logic further generates a parametric equation for each of the plurality of color space parameters.

7. The system of claim **6**, wherein the color space ink model comprises Weibull cumulative distribution function (CDF) parameters.

8. The system of claim **1**, further comprising a controller.

9. The system of claim **1**, wherein the at least one physical memory device to store ink deposition logic and the one or more processors coupled with the at least one physical memory device to execute the ink deposition logic to determine ink deposition data for an input color of the color space for the print system based on the color space ink model and an input color space value.

10. A method comprising generating color space ink model parameter data for a print system based on an ink deposition data and color space measurement data for one of a plurality of primary color inks for the print system, wherein the color space measurement data represents color response data for each of a plurality of parameters in a device independent color space and the color space ink model parameter data represents a relationship between each of the plurality of parameters of the device independent color space and ink deposition data for the one of the plurality of primary color inks for the print system.

11. The method of claim **10**, wherein the ink deposition data represents a relationship between the ink deposition and a print system input control for one of a plurality of inks for the print system.

12. The method of claim **10**, wherein the color space measurement data represents a relationship between each of the plurality of color space parameters and the print system input control.

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13. The method of claim **10**, further comprising generating a parametric equation for each of the plurality of color space parameters.

14. At least one non-transitory computer readable medium having instructions stored thereon, which when executed by one or more processors, cause the processors to generate color space ink model parameter data for a print system based on an ink deposition data and color space measurement data for one of a plurality of primary color inks for the print system, wherein the color space measurement data represents color response data for each of a plurality of parameters in a device independent color space and the color space ink model parameter data represents a relationship between each of the plurality of parameters of the device independent color space and ink deposition data for the one of the plurality of primary color inks for the print system.

15. The computer readable medium of claim **14**, wherein the ink deposition data represents a relationship between the ink deposition and a print system input control for one of a plurality of inks for the print system.

16. The computer readable medium of claim **14**, wherein the color space measurement data represents a relationship between each of the plurality of color space parameters and the print system input control.

17. The computer readable medium of claim **14**, having instructions stored thereon, which when executed by one or more processors, further cause the processors to generate a parametric equation for each of the plurality of color space parameters.

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